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Association between HIV infection and socioeconomic status: evidence from a semi-rural area of Southern Mozambique

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Abstract

Objectives: To analyse the association between socioeconomic status (SES) and HIV in Manhiça, a district of Southern Mozambique with one of the highest HIV prevalences in the world.

Methods: Data were gathered from two cross-sectional surveys performed in 2010 and 2012 among 1511 adults and from the household census of the district's population. Fractional polynomial logit models were used to analyze the association between HIV and SES, controlling for age and sex and taking into account the non-linearity of covariates. The inequality of the distribution of HIV infection with regard to SES was computed through a concentration index.

Results: Fourth and fifth wealth quintiles, the least poor, were associated with a reduced probability of HIV infection compared to the first quintile (OR=0.595, p-value=0.009 and OR=0.474, p-value<0.001, respectively). Probability of HIV infection peaked at 36 years and then fell, and was always higher for women regardless of age and SES. HIV infection was unequally distributed across the SES strata.

Conclusions: Despite the high HIV prevalence across the entire population of Manhiça, the poorest are at greatest risk of being HIV-infected. While women have a higher probability of being HIV-positive than men, both sexes showed the same infection reduction at higher levels of SES. HIV interventions in the area should particularly focus on the poorest and on women without neglecting anyone else, as the HIV risk is high for everyone.

Keywords: Africa South of the Sahara, HIV, HIV Seroprevalence, Social Class, Social Determinants of Health

Introduction

In 2015, 36.7 million people were estimated to be human immunodeficiency virus (HIV) positive worldwide. Nearly 70% of cases are concentrated in sub-Saharan Africa (SSA)(1). In heterosexual populations, women are more vulnerable to HIV infection than men due to a wide range of circumstances, including biological, social and cultural factors (2). This is particularly evident in SSA, where 56% of newly HIV-infected individuals are women (1).

In SSA socioeconomic status (SES) is a major determinant of HIV infection, with income, wealth and education being the most frequent proxies used to represent SES (3). However, there is no consensus on the rationale, magnitude and direction of the relationship between SES and HIV (4). The relationship between SES and HIV infection seems to be positive in some parts of SSA, with HIV prevalence being higher at higher levels of national income at the aggregate level (3,5–7), and HIV infection probability increasing with family wealth at the individual level (8,9). This positive association is stronger in countries with an uneven distribution of wealth (5,6).

However, other research on how wealth affects the probability of HIV infection found that in South Africa the poorest had the highest HIV-infection rates, the highest risk perception and the lowest education level(10). In SSA urban areas poor people had a greater probability of being HIV-infected than the wealthier population(11). Measurement of SES in sub-Saharan countries remains challenging because of the distinct social and economic structures established in rural and urban areas and the differences between men’s and women’s wealth(10,12).

Conflicting results are also obtained when education is used as a proxy for SES. A high education level is a positive determinant of HIV infection in some regions, while in other regions individuals with higher education levels are less likely to be HIV-infected (12–14). Importantly, the impact of education may differ by sex. Glynn et al. found that higher levels of education were protective against HIV infection among both women and men (15), whereas in Tanzania no statistically significant association between education and HIV infection in the overall population was found, but the stratification by sex showed a positive association for women and negative for men(9).

The different maturity of the HIV epidemic may also impact the association with education. During the early stages of the epidemic, education shows a positive association with HIV due to behaviours typical of individuals with high SES, such as premarital sex or multiple sexual partners. As the epidemic matures, higher education results in greater awareness of HIV and protective behaviours, rendering more educated individuals more protected against the risk of infection(16,17).

Besides wealth and education, other socioeconomic factors influence HIV infection. One of the leading causes of HIV spread is migration(6,16). Migrants are at higher risk of HIV infection because they are more likely to have unsafe sex and sex with multiple partners(2,18). Employment status is a further factor related to HIV infection that in some cases shows a different pattern for men and women(5,6,9). Finally, the area where people live is a predictor of HIV spread. HIV infection concentrates among urban residents, especially the urban poor(10,11).

This study aimed to provide further evidence on the association between HIV infection and SES and on the potential interaction between SES and sex, by analysing data from a semi-rural area of Southern Mozambique. This area is characterized by high migration levels to South Africa, a mature-stage HIV epidemic and an estimated 40% HIV prevalence in the community (19–21).

Methods

Study area and population

The study was conducted in the Manhiça district, a semi-rural area of Maputo Province, Southern Mozambique, with about 160,000 inhabitants in 2007 (22). The male population decreased over the last few years, possibly as a consequence of migration□□(23). People live predominantly in rural hamlets and the urbanization rate is 12%(24)□. There are two main towns in the district, Manhiça and Xinavane(23)□. 54% of the population is younger than 20 years (23)□. Two recent community-based surveys estimated the HIV prevalence in the community to be nearly 40% (19,20). Although the difference was not statistically significant, the HIV prevalence among women was higher (43.1%) than that among men (37.6%)(19).

Study design

We used sociodemographic data from the Demographic Surveillance System (DSS) of Manhiça Health Research Centre (CISM)(24). Data on HIV were collected in two cross-sectional studies in 2010 and 2012 (19,20). These two surveys involved individuals aged 18-47 years in the former, and 18-50 years in the latter, randomized from the DSS CISM dataset and stratified by age and sex. The sample size of each stratum was calculated with 0.05 precision assuming 20% HIV seroprevalence and a 95% confidence interval. The final samples were 722 subjects for the 2010 survey and 789 subjects for the 2012 survey. Data from the two cross-sectional studies (1511 subjects in total) were merged with information on household assets from a database generated also from the DSS CISM (24).

Data analysis

Construction of the wealth index

The SES of individuals was represented by a wealth index generated from assets owned by the family. The wealth index was computed by multiple correspondence analysis (MCA) for its appropriateness to analyse categorical data. MCA is a technique employed to extract one or several common underlying components from several correlated variables (25). MCA was applied to 18 variables indicating the possession of assets and their characteristics: type of construction of the main dwelling, kitchen and bath; fuel used; source of water and location of the source of water; whether or not the household had electricity, phone, radio, video reproducer, freezer, car, motorbike, television, computer, stove, bicycle or livestock. Subsequently, the sample population was categorised into five quintiles based on the distribution of wealth index.

Adjustment for non-participation

In the two cross-sectional studies used in this analysis, 87.5% of those who were invited agreed to participate. Despite this high rate, we adjusted our estimates for potential selection bias due to refusal to take part in the study. A variable distinguishing between those who accepted and those who refused was created for the total sample of individuals who were invited to participate. A logit model was computed with *acceptance/no acceptance* as the dependent variable and sex, age and wealth index as covariates. The predicted value of such a model constituted a propensity score assigned to each subject and representing the probability to accept. The detailed method has been described elsewhere(26,27).

Determinants of HIV infection: the logit models

Multivariate logit models were computed to assess the existence of a significant relationship between wealth index and HIV infection while controlling for other factors. The dependent variable was HIV infection. The control variables included in the multivariate models were previously tested through bivariate models: only those resulting significant in the bivariate models were included in the multivariate analysis. Two multivariate models were estimated. In the first one, the wealth index was included as a continuous variable, while in the second one this was split in quintiles. The potential interaction between sex and wealth index was tested by constructing the variable *interaction* (sex*wealth index). Fractional polynomials were used to estimate the multivariate logit models. This allowed to assess the association between HIV infection and continuous covariates when non-linear relationships were expected(28). Estimates were adjusted by the weights of the strata generated in the cross sectional studies and by the propensity scores generated for the adjustment for non-participation.

Concentration index and concentration curve

Based on the following equation, a convenient regression approach using ordinary least squares (OLS) model was used to compute the concentration index of HIV infection over the wealth index(29):

$$2\sigma_r^2\left(\frac{x_i}{\mu}\right) = \alpha + \beta r_i + \varepsilon_i$$

where the dependent factor $2\sigma_r^2\left(\frac{x_i}{\mu}\right)$ represents the variability of the HIV infection across the SES, x_i is the HIV serostatus of each individual i, μ is the mean value of HIV infection in the population analysed and $2\sigma^2_r$ is the two-tailed variance of the fractional rank. The fractional rank r_i is the order of the individuals across the wealth index distribution (i=1 for the poorest and i=N for the least poor). The dependent factor is regressed against a constant term α, the fractional rank of the individuals in the wealth index distribution and an error term ε_i(30). The estimated value of β represents the concentration index. Due to the fact that the HIV infection variable is dichotomous, the estimated value of β was normalized multiplying by the index 1/1-μ(31). The values of concentration indices range between -1 and 1, with -1 meaning absolute inequality, with the HIV infection concentrated among the poor. A concentration curve of HIV infection was generated using the *glcurve* command in Stata (30). Stata 13 (Stata Corp., College Station, Texas, USA) was the statistical software used to perform the analyses.

Ethical approval

The community-based HIV serosurveys were approved by the National Committee on Health Bioethics of Mozambique and the Hospital Clínic of Barcelona Ethics Committee. This study was approved by the Hospital Clínic of Barcelona Ethics Committee and conducted in accordance with the Helsinki Declaration.

Results

Of the initial 1511 subjects who accepted to participate in the two cross-sectional surveys, 1424 were included in the final analyses. 87 observations were lost during merging cross-sectional data with the database of assets owned, due to missing information in the latter database.

Table 1 shows the main characteristics of the study population. The sample was composed of 698 male and 726 female participants aged between 18 and 50 years. The average age was 34 years. 37% of the overall study population was HIV-positive: 33% of the men and 41% of the women. The age group with the highest HIV prevalence was between 38 and 47 years old (46%). Decreasing probability of HIV infection was observed as the level of wealth increased. The group with secondary schooling accounted for the lowest prevalence of HIV. The difference between the number of individuals who were HIV-positive and HIV-negative was statistically significant for all personal characteristics considered (Pearson's chi-squared independence tests p-values < 0.05).

The wealth index was represented by the first dimension of the MCA, which explained 84.5% of the total variability. The values of the wealth index ranged from -3.28 to 1.38. The highest scores referred to the poorest individuals and the lowest to the wealthiest. The values of the wealth index were reversed by multiplying by -1. The assets that represented the highest overall inertia and the highest contributions to the first dimension of the MCA were possessing a house made of conventional materials, an improved bath and a bath with cistern, a private water source in the yard, electricity, a video player, a freezer, a car, a television, a computer, a stove and using coal for food preparation.

The logit model estimated to adjust for non-response showed that differences of sex and age were statistically significant between those who agreed to participate and those who did not. Women were more prone to accept than men (OR=1.539, 95% CI [1.048 – 2.261], p-value=0.028), and age increased the propensity to accept (OR=1.027, 95% CI [1.005 – 1.049], p-value=0.016).

Bivariate analysis allowed choosing age, wealth index and sex for inclusion as covariates in the multivariate models (p<0.05). Schooling was not included in the final analysis because of the large number of missing values (n=140). However, schooling categories and quintiles of wealth were highly associated (Pearson Chi2 = 214.9351, p=0.000), suggesting that wealth is a good representation of education in this sample. According to the fractional polynomials approach, age was included in the multivariate model as $age^{-0.5}$ (*age_05*) and ln *age* (*age_ln*). The non-linearity of age was captured by including these terms. The wealth index was included as a continuous variable in the first multivariate model (*wealth index*), and by quintiles in the second (*wealth quintiles*) to capture the potential non-linearity of wealth. Interaction between sex and wealth index was not significant in the bivariate analysis and, therefore, it was not included in any multivariate model. Table 2 shows the values obtained for all variables in the bivariate and multivariate models.

Results of the multivariate logit model with continuous wealth index pointed to a significant association between HIV infection and SES (p<0.001). The odds ratio was 0.745 (95% CI [0.655 – 0.847], p-value=0.000) indicating a negative relationship, where the poorest population accounted for a higher risk of HIV infection than the least poor. Figure 1 shows the predicted probability of HIV-infected population from the model. Age and sex were also statistically significant. Women in the Manhiça district had a higher probability of being HIV-infected than men (OR=1.576, 95% CI [1.234 – 2.013], p-value=0.000). The model showed a non-linear relationship between HIV infection and age.

The model including wealth index quintiles also indicated a negative relationship between wealth index and HIV infection. The odds ratios of the quintiles decreased as the wealth index increased taking the first quintile (the poorest population) as the reference category. However, only the fourth and the fifth quintiles were statistically significant (p-values=0.009 and 0.000, respectively). Age and sex were statistically significant (p-values < 0.001) in this model, too. Being a woman significantly increased the probability of HIV infection (OR= 1.568, 95% CI [1.227 – 2.003], p-value=0.000). The age effect on HIV infection was confirmed as not linear. Figure 2 shows the association between age and HIV infection of the population by sex and with the wealth index split by quintiles. The probability of HIV infection increases with age until 36 years and then descends.

The concentration index of HIV infection of the population over the SES was – 0.480 indicating an unequal distribution of HIV infection, concentrated among the poor. The concentration curve (Figure 3) shows the graphical representation of the index. The concentration index is twice the area between the curve and the line of perfect equality.

Discussion

This study showed a significant negative association between SES and HIV infection: poorer individuals bear a higher probability of being HIV-infected. Importantly, the association was independent from sex. However, women were more affected by HIV than men in all wealth quintiles, at all ages. Although poor people showed higher probability of HIV infection, the probability of the rich is also very high.

Some previous studies, as well as the Mozambican National trend, pointed to a positive relationship between SES and HIV infection. Our results point to the opposite direction, suggesting that the association is context-specific and that our findings cannot be generalized to either other regions of Mozambique, or other countries.

The majority of studies pointing to a positive significant association between HIV infection and wealth attributed their findings to the sexual behaviours of the wealthy population(3,6,9,16). They argue that wealthier people can afford to maintain multiple partners and practice sex more frequently due to having time, economic resources and wider social networks(32). This is likely to apply to rural communities where the population is more isolated and the cost of maintaining multiple relationships is high. Our study population resides in Manhiça town, where many people work in sugar cane factories. Thus the area is not fully rural; it is also only 80 km away from the capital Maputo.

The maturity of the HIV epidemic can also explain our findings. At the beginning of an epidemic, the wealthiest individuals are more likely to engage in risky behaviours which normally imply high costs. When the epidemic matures, as it seems to be the case of Mozambique where the first case of HIV was detected in 1986(33), the whole population is exposed to the infection and the wealthiest individuals have the means to protect themselves(34).

Magadi et al. conducted a cross-sectional study in urban poor areas across SSA and found a negative association between HIV infection and wealth(11). They applied the rationale behind the economics of sexual behaviours to explain their findings, which may also elucidate, at least partly, our findings. They suggest that the poorest bear high risks of suffering both health and non-health related adverse events in life: they have a shorter life expectancy and are more vulnerable to events such as drought, floods, armed conflicts and other harmful circumstances(35,36). Therefore, the incremental risk of HIV infection is negligible from their perspective(36).

Further research is needed to understand the reasons why HIV infection concentrates among the poorest in Manhiça. Migration is likely to be a key factor. A previous analysis of the HIV seroprevalence data collected in 2012 and used in this work, pointed to the existence of a “hot spot” of HIV infection near a sugar cane mill in a village of the Manhiça district, an area characterised by immigration during the periods of peak activity of the factory(20). In addition to immigration from other areas, the whole district is characterised by emigration to neighbouring zones, particularly South Africa, where the HIV prevalence is very high. A limitation of this study was the impossibility to include migration status of individuals due to lack of data. Additional analyses are needed to explore whether and how migration is a cause of the spread of infection in Manhiça.

A non-linear age pattern of HIV infection was found for both men and women. The probability of HIV infection rose until the age of 36 years and then fell until 50 years, the oldest age included in our study. Other studies showed a similar non-linear pattern but this was obtained by categorizing the variable age (12,18). The advantages of using fractional polynomial approaches to model continuous variables such as age have been described elsewhere(37). The life expectancy at birth is around 50 years in Mozambique and premature death of the HIV-infected population compared to the overall population could be an explanation of our findings(38).

The concentration index obtained was negative (– 0.480) confirming an unequal distribution of the HIV infection in the Manhiça district: the poorest were more affected by HIV than the least poor. Only few studies computed a concentration index to analyse inequality in HIV infection. Hajizadeh et al. performed a large study using Demographic Health Surveys data from 24 SSA countries and found that in the majority of the countries, including Mozambique, HIV was concentrated in the wealthier population(5). Moreover, the Mozambican National HIV prevalence survey of 2009 found that the prevalence was higher among the least poor individuals of the country(39). The district of Manhiça does not follow the pattern found in Mozambique (concentration index=0.188), reinforcing the idea that the association between HIV and SES is context-specific.

This study used MCA instead of the more commonly used principal component analysis (PCA). PCA is the typical statistical method used to construct wealth indices based on assets despite being not appropriate for categorical data(40). The indices generated through the MCA agree well with consumption indices which are considered as the best representation of the real SES of the population(30,40). However, MCA agrees with PCA, and indicators obtained through the two approaches are comparable(40)

A remarkable feature of this study is the fact that it was possible to link data from the two cross sectional surveys to data from the sociodemographic census of the CISM DSS. This allowed to control for several potential confounding factors in the multivariate analyses. In addition, it was feasible to compute a propensity score to avoid selection biases in the cross-sectional data.

This study analysed SES as a determinant of HIV infection. However, the relationship between SES and HIV is complex and very likely to be bidirectional, implying both an upstream (SES affecting HIV infection) and a downstream effect (HIV/AIDS affecting SES)(41). Richer information, i.e. longitudinal data, to which more sophisticated methods such as quasi-experimental analyses are applied, is needed to determine the existence and magnitude of a causal effect of SES on HIV infection(13,42).

The identification of a simple association between SES and HIV rather than a causal relationship does not permit the drawing of conclusions for clear policy interventions. For example, it is not feasible to forecast that an improvement in socioeconomic conditions of the population will lead to a reduction of the HIV burden by means of this association (43).

Despite having identified vulnerable subgroups of the population in the area, namely the poorest and women of any socioeconomic condition, we cannot define HIV as a disease of poverty or as a gender-based disease. In fact, the least poor, despite bearing a lower probability of infection, still suffer a massive risk (probability of 30% for men and 40% for women in the 5th SES quintile). Although men are less likely to be HIV-infected than women, their probability of HIV infection is extremely high.

Conclusion

Despite the high probability of HIV infection for all individuals in this area of Southern Mozambique regardless of SES, the risk is highest for the poorest. Women are at greatest risk of being HIV-infected, regardless of SES. HIV interventions in the area should particularly focus on the poorest and on women but without neglecting anyone else, as the HIV risk is high for everyone in this community. Further research is needed on socioeconomic determinants of health in Manhiça district, particularly migration.

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Legends

Figure 1. Predicted HIV infection depending on wealth index by sex of Manhiça district population.

Figure 2. Predicted HIV infection of Manhiça district population depending on age, by sex and separated by wealth index quintiles.

Figure 3. Concentration curve for HIV infection in Manhiça district.

Table 1. Demographic characteristics of the sample population and HIV infection.

Table 2. Bivariate and multivariate logit models with HIV infection as dependent variable.

Table 1. Demographic characteristics of the sample population and HIV infection.

Characteristics	**Study population**			
	Total (n, %)[a]	**HIV-positives** (n, %)[b]	**HIV-negatives** (n, %)[b]	**P-value**[c]
HIV serostatus				-
Positive	531 (37.29)	531 (100)	-	
Negative	893 (62.71)	-	893 (100)	
Sex				0.003
Male	698 (49.02)	233 (33.38)	465 (66.62)	
Female	726 (50.98)	298 (41.05)	428 (58.95)	
Age (years)				0.000
18 to 27	414 (29.07)	91 (21.98)	323 (78.02)	
28 to 37	453 (31.81)	190 (41.94)	263 (58.06)	
38 to 47	445 (31.25)	206 (46.29)	239 (53.71)	
47 to 50	112 (7.87)	44 (39.29)	68 (60.71)	
Wealth index				0.000
1st quintile (poorest)	283 (19.87)	131 (46.29)	152 (53.71)	
2nd quintile	286 (20.08)	117 (40.91)	169 (59.09)	
3rd quintile	285 (20.05)	111 (38.95)	174 (61.05)	
4th quintile	285 (20.01)	97 (34.04)	188 (65.96)	
5th quintile (Least poor)	285 (20.01)	75 (26.32)	210 (73.68)	
Schooling[d]				0.000
Without schooling	106 (7.44)	52 (49.06)	54 (50.94)	
Primary education	765 (53.72)	314 (41.05)	451 (58.95)	
Secondary education	368 (25.84)	89 (24.18)	279 (75.82)	

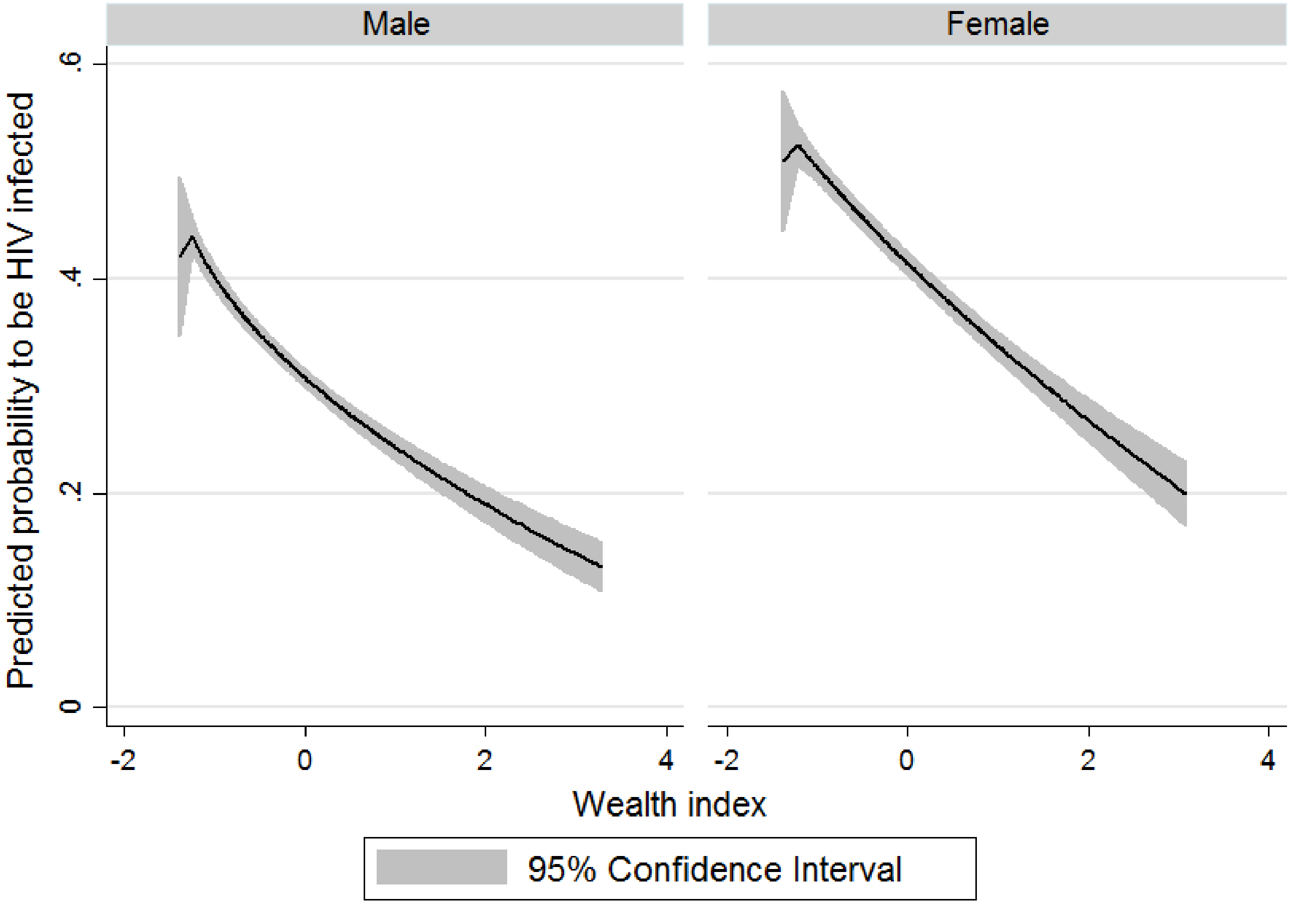
High education	41 (2.88)	13 (31.71)	28 (68.29)
Others	4 (0.28)	0 (0)	4 (100)

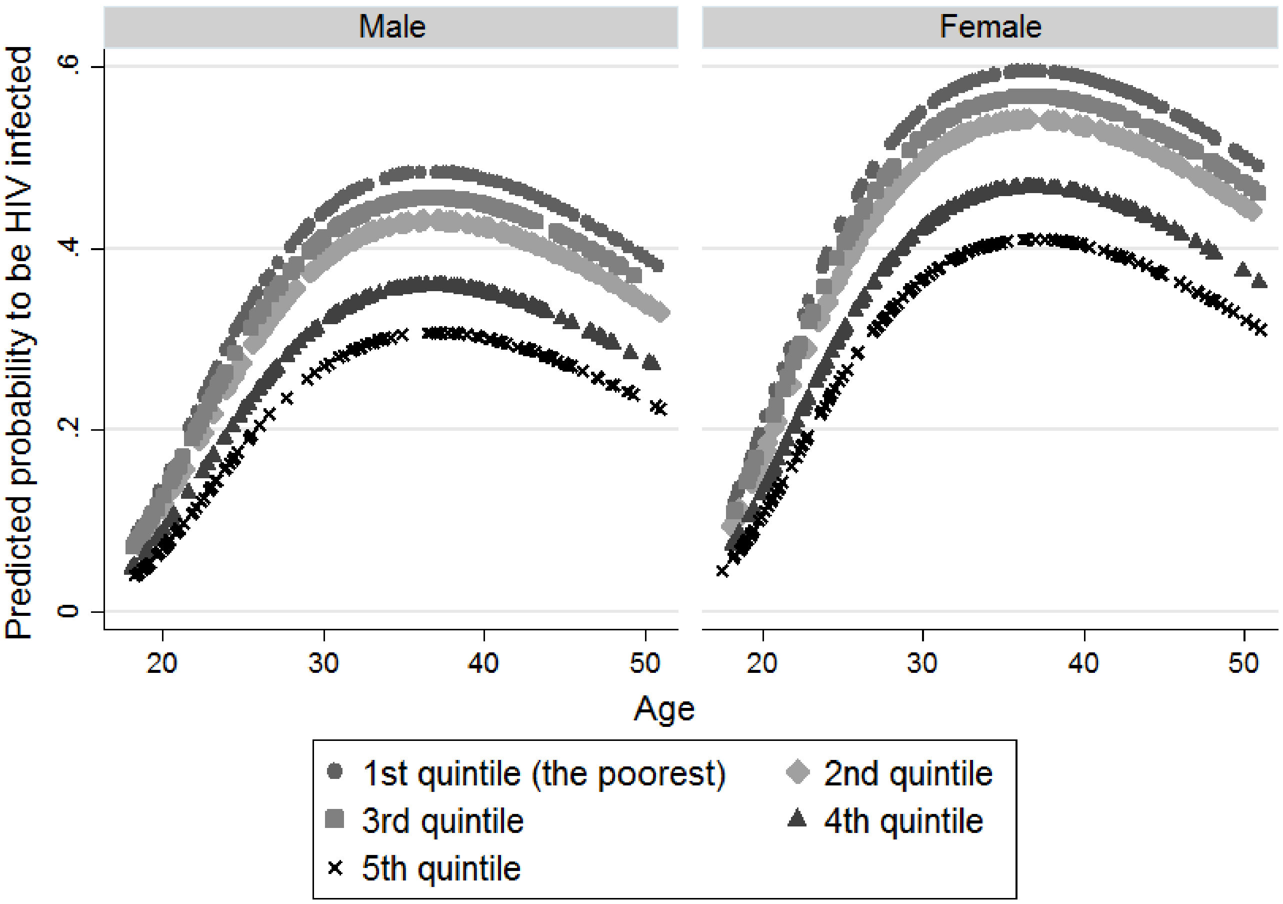
[a] Over the total number of observations (1424). / [b] Over the number of observations of each row. / [c] Pearson's chi-squared independence test p-value. / [d] Schooling has 140 missing values.

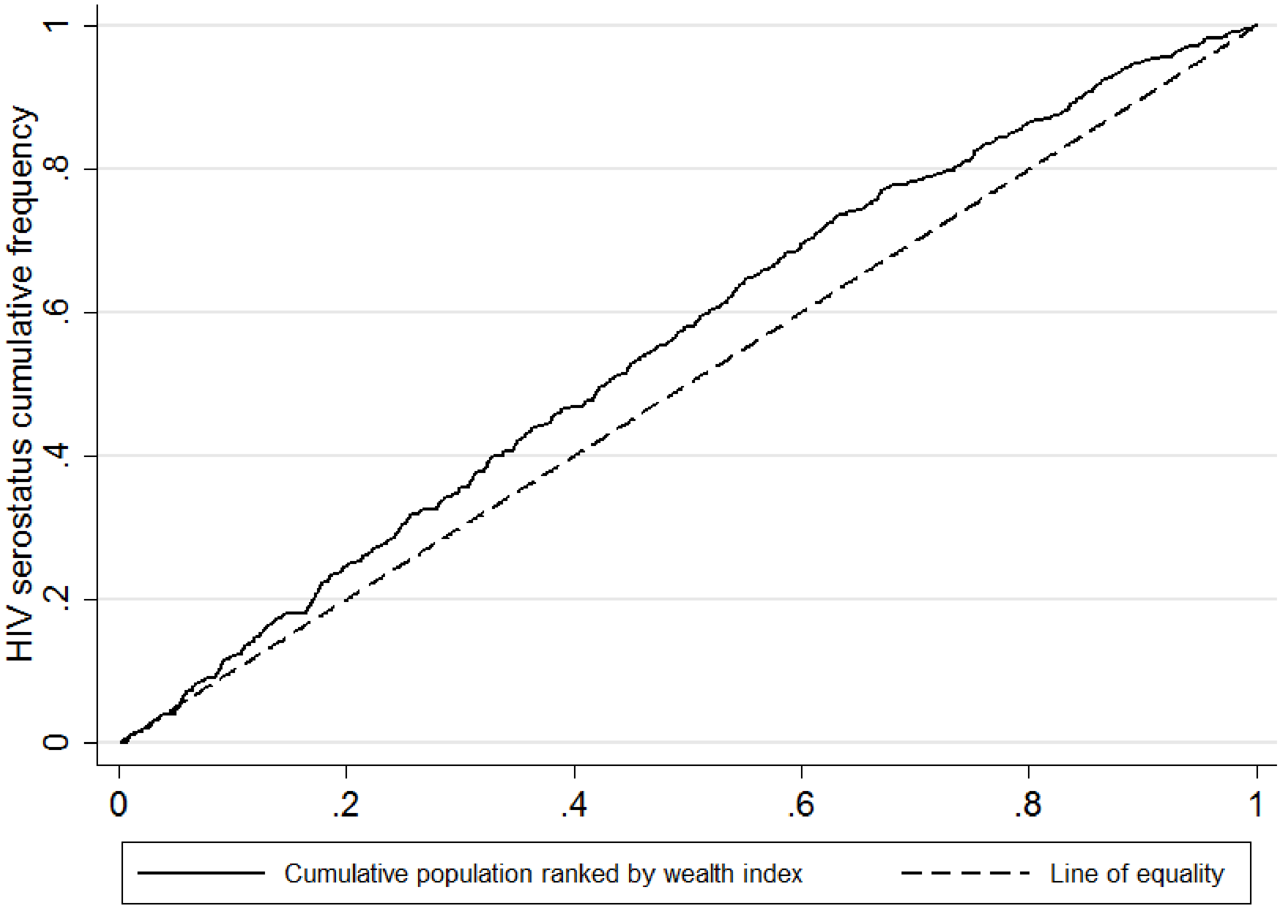
Table 2. Bivariate and multivariate logit models with HIV infection as dependent variable.

Variables	**Bivariate models**[d]			**Fractional polynomial multivariate model 1 (continuous wealth index)**[d]			**Fractional polynomial multivariate model 2 (wealth index in quintiles)**[d]		
	OR	CI	p-value	OR	CI	p-value	OR	CI	p-value
age	1.058	[1.045 – 1.071]	0.000						
age_05				$3{\cdot}10^{-89}$	$[4{\cdot}10^{-123} – 2{\cdot}10^{-55}]$	0.000	10^{-90}	$[9{\cdot}10^{-125} – 10^{-56}]$	0.000
age_ln				$5{\cdot}10^{-8}$	$[5{\cdot}10^{-11} – 0]$	0.000	$4{\cdot}10^{-8}$	$[3{\cdot}10^{-11} – 0]$	0.000
wealth index	0.710	[0.627 – 0.804]	0.000	0.745	[0.655 – 0.847]	0.000			
sex [a]	1.555	[1.237 – 1.955]	0.000	1.576	[1.234 – 2.013]	0.000	1.568	[1.227 – 2.003]	0.000
wealth quintiles [b]									
2nd quintile	0.807	[0.559 – 1.164]	0.252				0.805	[0.548 – 1.184]	0.270
3rd quintile	0.803	[0.557– 1.158]	0.239				0.892	[0.608 – 1.309]	0.559
4th quintile	0.566	[0.390 – 0.821]	0.003				0.595	[0.404 – 0.876]	0.009
5th quintile	0.410	[0.278 – 0.603]	0.000				0.474	[0.316 – 0.711]	0.000
schooling [c]									
Primary edu.	0.697	[0.447 – 1.085]	0.110						
Secondary edu.	0.303	[0.187 – 0.492]	0.000						
High edu.	0.476	[0.208 – 1.089]	0.079						
Constant				$5{\cdot}10^{40}$	$[2{\cdot}10^{24} – 2{\cdot}10^{57}]$	0.000	$2{\cdot}10^{41}$	$[9{\cdot}10^{24} – 2{\cdot}10^{58}]$	0.000

[a] The reference category is the male gender. / [b] The reference category is the 1st quintile. / [c] The reference category is no-schooling. / [d] All models computed over 1424 observations. / edu. = Education


Male
Female
Predicted probability to be HIV infected
0
.2
.4
.6
-2
0
2
4
-2
0
2
4
Wealth index
95% Confidence Interval


Male
Female
Predicted probability to be HIV infected
0
.2
.4
.6
20
30
40
50
Age
1st quintile (the poorest)
2nd quintile
3rd quintile
4th quintile
5th quintile


HIV serostatus cumulative frequency
0
.2
.4
.6
.8
1
0
.2
.4
.6
.8
1
Cumulative population ranked by wealth index
Line of equality